Nora Loose

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Research Interests

Physical & computational oceanography, Ocean mesoscale eddy parameterizations, Machine Learning, Scientific software development, Uncertainty quantification, Adjoint modeling, Ocean observing system design

Education

01/2015 -
08/2019
University of Bergen, Bergen, Norway.
Ph.D. in **Physical Oceanography**
- Thesis: *Adjoint Modeling and Observing System Design in the Subpolar North Atlantic*
- Advisors: Kerim H. Nisancioglu (University of Bergen), Patrick Heimbach (UT Austin)
- Funded by European Research Council project ice2ice

04/2007 -
02/2013
University of Bonn, Bonn, Germany.
Diploma (equiv. M.Sc. degree) in **Mathematics**, **with Honors**
- Specialization: Stochastic Analysis; Minor: Physics
- Grade Point Average: 1.0, on a scale from 1.0 (excellent) to 4.0 (pass)

Research Experience

10/2022 -
present
Postdoctoral Research Associate, *Program in Atmospheric and Oceanic Sciences*, Princeton University.
- Member of the M2LInES project
- Apply machine learning methods to accelerate and improve ocean mesoscale eddy parameterizations
- Mentors: Alistair Adcroft & Laure Zanna

10/2020 -
09/2022
Postdoctoral Associate, *Department of Applied Mathematics*, University of Colorado, Boulder.
- Member of the Ocean Transport and Eddy Energy Climate Process Team
- Improved ocean mesoscale eddy parameterizations via an energetically-consistent framework
- Developed open source software for spatial filtering of gridded geophysical data
- Mentor: Ian Grooms

09/2019 -
09/2020
Postdoctoral Fellow, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin.
- Leveraged adjoint modeling and uncertainty quantificaiton for ocean observing system design
- Mentor: Patrick Heimbach

1/2015 -
06/2018
Graduate Researcher, *Department of Earth Science*, University of Bergen, Norway.
- Investigated oceanic teleconnections in the North Atlantic, Nordic Seas, and Arctic Ocean
- Quantified uncertainties in ocean state estimates for present-day and paleo climates

03/2013 -
08/2014
Doctoral Research Fellow, *Department of Mathematics*, ETH Zurich, Switzerland.
- Conducted research in the fields of Geometric Analysis and Partial Differential Equations
- Assisted in teaching undergraduate and graduate level courses

Teaching and Outreach

08/2020
Science Communication.
- Worked with Science Educator Annette deCharon to develop a ArcGis Story Map that explains adjoint modeling and a recent research article to a broader audience

02/2020	**Volunteer**, *Girl Day STEM Festival*, UT Austin.
	○ Hands-on science activities and demonstrations for elementary and middle school students
03/2013 -	**Teaching Assistant**, *Department of Mathematics*, ETH Zurich, Switzerland.
08/2014	○ Taught 3 graduate level math courses (*Measure Theory & Integrals, Differential Geometry I, II*)
	○ *Teaching evaluations*: 4.8 (2013), 4.9 (2014) on a scale from 1 (very bad) to 5 (excellent)
07/2013	**Teaching Assistant**, *PCMI Graduate Summer School*, Park City, UT.
	○ Taught advanced math course (*Weak immersions of surfaces with L^2-bounded second fundamental form*, lecture notes) for Ph.D. students and postdocs
10/2008 -	**Teaching Assistant**, *Department of Mathematics*, University of Bonn, Germany.
02/2013	○ Taught 3 undergraduate level math courses (*Mathematics for Physicists I, Analysis II, III*)
01/2010 -	**Teaching Assistant**, *Department of Mathematics*, University of Toronto, Canada.
04/2010	○ Taught undergraduate level math course (*Linear Algebra*)
2009 - 2011	**Student Assistant**, *Hausdorff Center for Mathematics*, University of Bonn, Germany.
	○ Organized and led math outreach events for students from elementary and secondary school

Funded Grants

08/2021-	**NSF CSSI Grant**, *National Science Foundation*, $166,590.
07/2025	○ Project: Collaborative Research: Frameworks: Convergence of Bayesian inverse methods and scientific machine learning in Earth system models through universal differentiable programming
	○ Role: Principal Investigator (Lead PI: Patrick Heimbach, UT Austin)
02/2016	**Research Grant**, *Norwegian Research School in Climate Dynamics*, NOK 20,000.
	○ for research stay at MIT

Awards and Scholarships

04/2019	**Rising Stars in Computational & Data Sciences**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin.
	○ Selected for competitive, international career event for women in Computational & Data Sciences
03/2018	**Best Presentation Award**, *Research School on Changing Climates in the Coupled Earth System*, Sommarøy, Norway.
02/2013	**Award "Diploma with Honors"**, *Department of Mathematics, University of Bonn, Germany*, for graduating with highest possible grade point average.
2008 - 2012	**German Academic Scholarship Foundation Award**, *Studienstiftung des deutschen Volkes*, for outstanding academic achievements (given to 0.5% of students in Germany).
2006	**3 Awards**, *for exceptional results in high-school final exams on state-wide basis.*
	○ *Porsche AG*: for excellent performance in mathematics and physics
	○ *German Physical Society*: for excellent performance in physics
	○ *Reinhold Beitlich Foundation*: for exceptional overall performance

Mentoring

08/2022	Mentor for a coding project as part of OceanHackWeek 2022
06/2022 -	Writing Mentor for an undergraduate student as part of the SOARS program
07/2022	
10/2021 -	Mentor for a CU Boulder undergraduate student as part of the PROGRESS mentorship
present	program

| 03/2022 - present | Mentor for 2 students as part of the ASLOMP mentorship program |

Professional Service

Organization of Conferences

08/2022	Co-Organizer of OceanHackWeek 2022.
02/2022	Co-Convener for the session "Mesoscale Eddy Energy and Ocean Transport", Ocean Sciences Meeting 2022.
04/2017	Co-Convener for the session "Quaternary climate archives and proxy uncertainty", EGU General Assembly 2017.
09/2015	Co-Organizer of PhD conference "Connecting the ocean, atmosphere and ice sheets", 20 participants, Denmark.

Membership of Scientific Projects and Societies

| 09/2022 - present | Working group "'NEMO working group on machine learning and model uncertainty" |

Publications

In Preparation

N. Loose et al. Parameterizing eddy form stress in a residual-mean isopycnal model, *in preparation for Journal of Advances in Modeling Earth Systems*.

Preprints

P1   **N. Loose**, S. Bachman, I. Grooms and M. Jansen. Diagnosing scale-dependent energy cycles in a high-resolution isopycnal ocean model, *submitted to Journal of Physical Oceanography*, Preprint doi: 10.1002/essoar.10511055.1.

Journal Arcticles

J6   G. Marques, **N. Loose**, E. Yankovsky, J. Steinberg, C-Y Chang, N. Bhamidipati, A. Adcroft, B. Fox-Kemper, S. Griffies, R. Hallberg, M. Jansen, H. Khatri and L. Zanna. NeverWorld2: An idealized model hierarchy to investigate ocean mesoscale eddies across resolutions, *Geoscientific Model Development 15, no. 17: 6567-79*, doi: 10.5194/gmd-15-6567-2022.

J5   **N. Loose**, R. Abernathey, I. Grooms, J. Busecke, A.P. Guillaumin, E. Yankovsky, G. Marques, J.M. Steinberg, A.S. Ross, H. Khatri, S.D. Bachman, L. Zanna, P. Martin. GCM-Filters: A Python Package for Diffusion-based Spatial Filtering of Gridded Data, *Journal of Open Source Software, 7(70), 3947*, 2022. doi: 10.21105/joss.03947.

J4   I. Grooms, **N. Loose**, R. Abernathey, J.M. Steinberg, S.D. Bachman, G. Marques, A.P. Guillaumin, E. Yankovsky. Diffusion-Based Smoothers for Spatial Filtering of Gridded Geophysical Data, *Journal of Advances in Modeling Earth Systems*, 13, e2021MS002552, 2021. doi: 10.1029/2021MS002552.

J3 **N. Loose** and P. Heimbach. Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems, *Journal of Advances in Modeling Earth Systems*, 13, e2020MS002386, 2021. doi: 10.1029/2020MS002386.

J2 **N. Loose**, P. Heimbach, H. Pillar and K.H. Nisancioglu. Quantifying Dynamical Proxy Potential through Shared Adjustment Physics in the North Atlantic, *Journal of Geophysical Research: Oceans 125, no. 9*, 2020. doi: 10.1029/2020JC016112. Selected as Eos Research Spotlight.

J1 Y. Fujii, E. Rémy, H. Zuo, P. Oke, G. Halliwell, F. Gasparin, M. Benkiran, **N. Loose**, J. Cummings, J. Xie, Y. Xue, S. Masuda, G.C. Smith, M. Balmaseda, C. Germineaud, D.J. Lea, G. Larnicol, L. Bertino, A. Bonaduce, P. Brasseur, C. Donlon, P. Heimbach, Y. Kim, V. Kourafalou, P-Y. Le Traon, M. Martin, S. Paturi, B. Tranchant and N. Usui. Observing System Evaluation Based on Ocean Data Assimilation and Prediction Systems: On-Going Challenges and a Future Vision for Designing and Supporting Ocean Observational Networks, *Front. Mar. Sci. 6:417*, 2019. doi: 10.3389/fmars.2019.00417.

Thesis

T1 **N. Loose**. Adjoint Modeling and Observing System Design in the Subpolar North Atlantic, *Ph.D. Dissertation*, University of Bergen, 2019. http://bora.uib.no/handle/1956/24456.

Selected presentations

Invited Talks

07/2022 **M^{2}LInES working group - Ocean Turbulence**, *Online*.
Extracting mesoscale eddy dynamics via spatial filtering: python tools and energy diagnostics

01/2022 **20th DRAKKAR Ocean Modelling Workshop (Invited Keynote Talk)**, *Online*.
Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems

12/2021 **Ocean Circulation and Climate Dynamics Colloquium, GEOMAR Kiel**, *Online*.
Oceanic teleconnections in the North Atlantic: From dynamical proxy potential to observing system design

06/2020 **IARPC Joint Modeling-Arctic Observing Systems Sub-Team Meeting**, *Online*.
Looking at observing systems through the lens of models: Targeted Observations

04/2018 **EGU General Assembly 2018 (solicited)**, *Vienna, Austria*.
How informative are SST proxy data in paleoceanographic inverse modeling?

03/2018 **Northumbria University**, *Newcastle, UK*.
Uncertainty Quantification and Constraints on Subsurface Heat Content at Greenland's Margins

Conference Talks

07/2022 **JuliaCon Minisymposium 2022: Differentiable Earth system models in Julia**, *Online*.
Adjoints for uncertainty quantification and observing system design

04/2022 **Ocean Sciences Meeting 2022**, *Online*.
Diagnosing scale-dependent Lorenz and Bleck energy cycles in a high-resolution layered model

01/2022 **12th Symposium on Advances in Modeling and Analysis Using Python, AMS Meeting**, *Online*.
GCM-Filters: A Python Package for Spatial Filtering Analysis of Gridded Data from Ocean and Climate Models (slides)

02/2021 **2021 CESM Ocean Model Working Group Meeting**, *Online*.
Diagnosing and parameterizing the energy budget of ocean mesoscale eddies in an idealized model

02/2020 **Ocean Sciences Meeting 2020**, *San Diego, CA*.
The Dynamical Proxy Potential of the OSNAP Array

10/2018 **ECCO Meeting**, *Austin, TX*.
Comprehensive Observing System Design within the ECCO Framework

07/2018 **Workshop on Sensitivity Analysis and Data Assimilation in Meteorology and Oceanography**, *Aveiro, Portugal*.
Uncertainty Quantification as a Tool for Observing System Design - An Oceanographic Perspective

06/2018 **Adjoint (TACOMA) Workshop**, *Oxford, UK*.
Adjoints as a Tool for Observing System Design

Conference Posters

06/2017 **Data Assimilation Workshop**, *Bergen, Norway*.
How Informative are Paleoceanographic Observations for an Inverse Problem?

05/2017 **Past Global Changes (PAGES) Workshop**, *Louvain-la-Neuve, Belgium*.
How Informative are Paleoceanographic Observations for an Inverse Problem?

03/2017 **Workshop on Emerging Applications of Data Assimilation in the Geosciences**, *Leiden, Netherlands*.
Uncertainty Quantification for Adjoint-Based Data Assimilation with Sparse Data

Field Work

07/2017 - **East Greenland Ice-Core Project (EastGRIP)**, *Greenland*.
08/2017 ○ Drilled shallow ice cores, conducted surface measurements and lab work in the science trench

08/2016 - **G.O. Sars**, *Irminger Sea*.
09/2016 ○ Collected physical oceanographic data and marine sediment cores for the ice2ice project (ERC)

Technical Strengths

○ **Computer Languages**: Python (xarray, dask, numpy, scipy), MATLAB, Fortran, shell scripting
○ **Software Contributions**: GCM-Filters
○ **Visualization & Design**: Cartopy, Matplotlib, LaTeX, HTML
○ **Data & Databases**: NetCDF, Zarr
○ **Platforms**: HPC, JupyterLab, GitHub